UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

CALIFORNIA CENTER for INNOVATIVE TRANSPORTATION
2105 BANCROFT WAY, SUITE 300 - MAILCODE 3830
BERKELEY, CA 94720-3830
Phone: (510) 642-4522 Fax: (510) 642-0910

August 1st, 2007

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street S.W.
Washington, D.C. 20554

Re: WT Docket No. 06-49
Ex Parte
Amendment of the Commission's Part 90 Rules in the 904-909.75 and 919.75-928 MHz Bands

Dear Ms. Dortch:

The California Center for Innovative Transportation (CCIT) was co-established by the California Department of Transportation (Caltrans) and the University of California at Berkeley to promote and accelerate the deployment of technologies that make our transportation system safer, cleaner, and more efficient.

I am writing to express support for the existing rules governing the use of M-LMS licenses, and ask that the Commission discards the Notice of Proposed Rulemaking that is currently under review.

Intelligent Transportation Systems (ITS) encompass the application of information and telecommunications technologies to the transportation industry. Today, our nation's transportation infrastructure is saturated in many areas, and adding new capacity is often impossible due to land use and environmental constraints. Like many transportation experts, I believe that ITS is critical to maintaining and enhancing the safety and level of service on our roadways and railways.

Wireless communications are a critical part of delivering state-of-the art ITS services. As the Commission knows, there are two sets of radio spectrum licenses that have been designated for ITS applications. One is M-LMS, in the 902-928 MHz frequency range, applicable for wide-area long-range communications, and the other is Dedicated Short-Range Communications (DSRC), in the 5.9 GHz frequency range, for short-range applications. Each frequency range has its own advantages. DSRC constitutes the backbone of the Federal Highway Administration's (FHWA) Vehicle-Infrastructure

Integration (VII) initiative and will enable critical safety applications. A wide-area network based on the M-LMS can cost-effectively provide location and monitoring services.

The proposed rulemaking would relax some of the constraints associated with the use of M-LMS licenses, such that the radio spectrum would become available for general purposes outside of transportation. I understand that this may, at least in part, be in response to the fact that M-LMS licensees have not yet built out significant networks. However, I urge the Commission to consider the follow points:

1. The Commission created this license with a clear public-interest goal and not for general commercial use. The Commission has long maintained that this kind of radio service is important and the fact that development has not happened yet does not diminish its importance.

2. Many technical, economical, and institutional elements have changed in recent years, creating far more favorable conditions for the deployment of a wide-area wireless network using the M-LMS licenses. Most notably:

a. The costs of network and radio equipment, as well as displays and user interface components, have fallen tremendously in recent years thanks to the proliferation of mobile communications and the Internet.

b. The market for ITS services with the potential to consume large amounts of wireless bandwidth is developing rapidly. For instance, sales of in-car navigation systems have experienced triple-digit growth over the past couple of years.

c. Core research into GPS-augmentation using ground-based transmitters (pseudolites) has only taken place in recent years[1]. Such research is directly applicable to the design of a network that can provide ground-based location services, as required under the current rules for M-LMS licenses.

d. New wireless networking protocols[2] are available to make frequency-hopping and multi-band spectrum sharing feasible. This allows M-LMS services to be tightly integrated with other radio services, thus boosting their economic feasibility.

e. The FHWA's VII initiative is generating interest for networks of connected vehicles from the transportation industry. As a result, there may be far more support and potential uses for a wide-area network complementing DSRC than in years past.

3. If the NPRM is adopted, the reduction of effective radio power (ERP) allowed under the M-LMS licenses would likely make building a wide-area ITS wireless network cost-prohibitive. This is because the new limits would result in smaller cell sizes, thereby requiring additional towers to achieve the same coverage.

4. The current M-LMS rules require that licensees provide ground-based location services by multilateration. Such services could augment the accuracy and integrity of Global Navigation Satellite Systems. They could also provide a backup to the U.S. GPS in case its signal is jammed or spoofed, a scenario that is seriously considered by security experts. The NPRM would virtually eliminate the possibility that location services are developed using the M-LMS radio spectrum.

---

[1] Chris Rizos (http://www.gmat.unsw.edu.au/snap/staff/chris_rizos.htm) started much of this research in 1999, see http://www.gmat.unsw.edu.au/snap/publications/rizos_2005a.pdf and http://www.gmat.unsw.edu.au/snap/work/theme4.htm. Other links: http://pdf.aiaa.org/preview/CDReadyMICSSC04_940/PV2004_3181.pdf and http://www.novatel.com/Documents/Papers/File45.pdf

[2] Including TDS-OFDM, TETRA-2, and DVB-H

5. No M-LMS licensee has announced concrete plans to use the more "flexible" licensing scheme proposed under the NPRM. On the other hand, Telesaurus, LLC, of Berkeley, CA, and the Skybridge Spectrum Foundation are developing plans based on existing M-LMS licenses. CCIT, with sponsorship from Telesaurus, is contributing to these efforts. As it stands, the NPRM will not enable a clear public-interest goal.

While public commercial wireless and governmental private wireless will continue to play substantial roles in ITS, an industry-specific wide-area wireless network would offer standardization and customization to meet the unique needs of transportation applications. Such a network would increase the likelihood of ITS services being adopted by end users, transportation public agencies, automobile makers, and other transportation stakeholders.

ITS services increasingly provide critically needed benefits to the nation, reducing congestion, pollution and transportation accidents. The existing ITS radio services—both M-LMS and DRSC—wisely established by the Commission, should be fully supported and maintained by the Commission and in no case adversely amended or diverted to other purposes.

Accordingly, I hope that the Commission will maintain the current M-LMS rules and make it possible to develop wide-area radio services for ITS applications nationwide. Thank you very much for your consideration.

Sincerely,

Hamed Benouar
Director
California Center for Innovative Transportation

1 Attachment:
Joint CCIT-Telesaurus paper submission for the 2007 World Congress on Intelligent Transportation Systems

ITS WIDE-AREA WIRELESS NETWORKS

Saneesh Apte
Associate Development Engineer
California Center for Innovative Transportation
2105 Bancroft Way, Berkeley CA 94720-3830, United States
(510) 642-5478 – san@calccit.org

J.D. Margulici
Senior Development Engineer
California Center for Innovative Transportation
2105 Bancroft Way, Berkeley CA 94720-3830, United States
(510) 642-5929 – jd@calccit.org

Warren Havens
President
Telesaurus LLCs - ITS Group
Berkeley California, United States
(510) 814-2220 – warrren.havens@sbcglobal.net

ABSTRACT

The California-based consortium of Telesaurus LLCs and related nonprofit foundations have acquired FCC radio spectrum licenses throughout the United States for wide-area location, data, voice, and other intelligent transportation systems (ITS) services. Telesaurus intends to partner with government, TV stations, power utilities and other infrastructure enterprises to offer nationwide wireless ITS services. The California Center for Innovative Transportation (CCIT) is investigating such wide-area networks from public-policy, technical, and economic perspectives. This paper presents the methodology and some early findings. Of particular interest is the possible tight integration between wide-area and short-range ITS wireless networks, specifically dedicated short-range communications (DSRC).

MAIN TEXT

INTRODUCTION

Background

Over the past several years, a Berkeley California based consortium of Telesaurus LLCs and the related nonprofit Skybridge Spectrum Foundation (together "Telesaurus"), has acquired substantial radio spectrum in the lower 200 MHz and 900 MHz "LMS" ranges authorized for use in the vast majority of the United States (US) for location, data, voice, and other intelligent transportation systems (ITS) services (principally under Title 47 CFR Part 90 Subpart M). Telesaurus is also eligible under FCC rules to use DSRC spectrum in the 5.9 GHz range) nationwide. The California Center for Innovative Transportation (CCIT), which focuses on the deployment of transportation technology, and works with researchers, public agencies, and innovative companies, is investigating how this spectrum can be leveraged to deploy wide-area wireless networks for ITS services.

Vision

The vision that drives the present investigation is a standards-based nationwide ITS-centric wireless network providing ITS services with applications for commuters, travelers, government, commercial fleets, transportation operators, first responders, as well as other communication, position, navigation, and timing services.

The network would be unique in the United States in (1) its use of especially suitable radio spectrum (200, 900, and 5900 MHz) and architecture for mobile, vehicular (and other long-range) wireless coverage and links, (2) in its efficient design and operation for ITS and related Energy and Environmental applications, and (3) as critical nationwide supplement and backup of GPS. In sum a nationwide ITS, Energy, and Environment Wireless Network.

These high public-interest network functions, mostly not-for-profit and closely tied to governmental goals and operations, would be subsidized and sustained by compatible commercial applications built upon the success of the former. Telesaurus has advocated a synergistic “public-private” approach from its inception.

Envisioned network components and applications are described below.

Scope

In partnership with Telesaurus, the goal of the CCIT investigation is to explore the concepts and key features of a wide-area wireless network that would serve transportation and related sectors. Providing ITS services and applications over such a network is an ambitious project that raises a set of fundamental questions: (A) What exact services and applications would be provided? (B) What technologies would enable the network? (C) What value would the network add to existing and planned ITS services and initiatives? (D) Who would support or partner to realize the initiative and how? (E) What work in these areas has been done by others in the ITS field in the US and internationally?

Answering those questions requires not only analyzing technical and business elements, but also factoring in stakeholders’ perspectives, including local and state transportation authorities, the FCC and US DOT, established ITS companies, wireless equipment manufacturers, automobile companies, ITS entitles in other nations, and the like.

AREAS OF INVESTIGATION

At this phase the investigation concentrates on concept exploration to assess the technological, economic, business, and institutional feasibility of the network. We start with needs, then look at technology, and ultimately intend to outline deployment steps.

Determine Network Services

The first question to be asked is what needs or opportunities would the network fill. A wireless network providing wide-area, core ITS services may enhance the safety and security of the transportation system, ease congestion, and reduce pollution in significant ways. The proposed network may provide services to three major groups—the traveling public and vehicle fleets, transportation operators, and public safety agencies. All three groups currently consume various wireless services, and in order for the proposed network to improve the value delivered to each group, it is necessary to understand current utilization. We will therefore survey and classify existing and planned services to potential users and extrapolate to determine how an ITS-specific wide-area wireless network would add value, either by enhancement or introduction of services.

Technology and Standards

This area of investigation consists of surveying current and developing technologies and evaluating which are best positioned for the envisioned network. The choice of wireless protocols and related technologies will substantially influence what services can be offered on the network. The set of requirements and constraints to be considered include: signal modulation, priority settings, privacy, mixing multiple services and user categories, maintaining bandwidth and reliability, terrestrial wide-area pseudolite and GNSS location and timing, etc. We will review technical standards and protocols including those involving DSRC- VII, ISO TC 204 and 211, CALM, CVIS, GST, dedicated mobile wideband digital broadcast and use of non-peak capacity of digital TV stations, wide-area pseudolites, TETRA releases, WiMax, WiFi, MIMO, optimization of vehicle platform for communications including integration of mobile WWANs and WLANs, integration with commercial wireless networks, etc.

Implementation and integration into the existing ITS landscape

Implementation in the ITS world requires more than technology. Identified needs, funding, champions, user acceptance and institutional support is the name of the game. A key implementation question underling the development of a wide-area wireless ITS network is how the network will complement, enhance, or replace other networks, existing or planned. This includes the Federal vehicle-infrastructure integration initiative (VII) (DSRC-based), networks deployed by state and local transportation authorities, commercial wireless networks, GPS and GNSS, outfitting government fleets, and other future networks such as municipal broadband and 4G. A clear picture of the interactions with these other networks will be required to move forward.

Another key aspect of the implementation strategy is the necessity to deploy the system in successive, scaled stages. This is necessary because the proposed network concept is large, pervasive, and depends on the adoption and attachment of add-on third-party services. Therefore the analysis will separate what can be accomplished quickly from the longer-term vision, and establish a path between those two points.

EARLY FINDINGS

Physical Network Overview

The envisioned network has three main hardware system components, and a fourth ancillary component, each with wide-area coverage. (1) “Broadcast”-- long-range broadcast stations to provide a high volume of one-way traveler information to vehicles, (2) “TwoWay”--

medium-range stations along the roadways for vehicles to send small but frequent amounts of information back and for certain two-way communications, and (3) “Location”-- pseudolite location stations mostly collocated with the Broadcast and Two-Way stations. The Two-Way stations can initially be built every tens of miles along the roadway (and other near routes, rail-lines, utility pipelines, etc.), as analog cellular did in its early stage, to provide the talk-back and two-way functions from whatever nodes (vehicles) are present, and can later be made denser as the number of nodes increase.

This set-up is much more efficient than commercial wireless networks since the bulk of the information is broadcast rather then sent point-to-point, since coverage to vehicles requires less stations than to handheld radios, and since the network will be designed to be extensible so adding nodes is uncomplicated. Also, commercial mobile phone providers are limited by their current network set-up in the number of cell sites they can add without self-interference: a limitation absent in wide-area broadcast from one or numerous same-channel stations.

Further, the Broadcast and Two-Way stations and their timing components can be used as platforms for the Location stations employing TDOA signals for GNSS pseudolite enhancement (4) “Fixed Wireless”-- Finally, all three main network station classes can provide wireless communication, location and timing services to the network itself, for roadway authorities, and for environmental monitoring, via fixed wireless links (including movable devices such as certain electronic highway signs). Fixed Wireless is a supplemental fourth network component class using the spare capacity of the three main components. With essentially the same amount of FCC licensed spectrum everywhere (and using similar system architecture) there will always be substantial spare capacity outside the urban areas with highest traffic: areas where Fixed Wireless is especially important and certain capacity for Fixed Wireless will be reserved in all areas.

Application Classes

Described above are several examples of applications that could become available on the envisioned network, but because there are so many, it is useful to combine them into groups or application classes. This kind of structure has two uses, one is to understand what kinds of network services are needed to enable a particular application class and help design the network architecture, and the other is to present, in a uniform way, the world of possible uses to potential partners, stake-holders, or other interested parties. Also, while there is overlap, we group the classes into several broad groups.

Identified application classes and class groups include:

<u>Essential Information Group—Traveler & Road Information Reporting & Collection</u>

- Traveler Information Dissemination—Continual dissemination of publicly available data to vehicles most essential for travel. Includes, but not limited to, traffic, weather, and detour information, transit, airline and rail schedules & conditions, road tolls & fast lane options, critical roadside merchants & facilities, etc.

- Traffic and Environmental Data Collection—Regular collection and upload of traffic and environmental data from vehicles (equipped with “probes”) to the network, including, but not limited to, vehicle location & speed, current road conditions, and forwarding the date to public authorities and others.

Location, Navigation, Control & Timing Group—E911, AVC, AVL & Others

- Enhanced-911—Applications where, in emergencies, a vehicle or occupant transmits its position and status, in data and voice, for efficient dispatch of services, including automatic crash notification.

- Automatic Vehicle Control ("AVC")—Applications of roadway authorities for critical safety control of vehicles, e.g., Intelligent Speed Adaptation (ISA), lateral lane control, and non-emergency wireless communication control (restrictions in severe road conditions).

- Vehicle Navigation and Parking—Applications providing step-by-step real-time directions, digital maps, alternative routing (based on ETOA speed, and other criteria), and (with cooperation of facility authorities) parking directions to available spaces.

- AVL and Fleet Management Applications—Applications that require the real time tracking of and essential communications with a fleet of vehicles (public or private). Can also apply to non-vehicle objects, such as shipping containers, heavy equipment, etc.

- Special PNT—Special applications (other than ITS) involving Position, Navigation, and/or (precise) Timing, using the Network's wide-area pseudolite-GNSS hybrid subsystem. For example, this could (i) back up and/or extend-enhance similar localized hybrid systems at major airports, and for construction, agriculture, resource extraction, seismic-monitoring, robotic repair, rescue and missions, and other operations, (ii) back up GPS-GNSS location and timing over wide regions if it was deliberately jammed or spoofed, or otherwise fails, (iii) back up and extend GPS-GNSS timing for various operations and industries.

DSRC-VII Extension Group

- Carrying on DRSC Applications on WAN—Applications using the planned Wide Area Network (WAN) to extend over geography and in time many of the essential Vehicle to Roadside, and Vehicle to Vehicle Dedicated Short Range Applications (DSRC) applications planed for the US DOT's VII localized systems. (See below section for more on this Group and its rationale.)

ITS & Public Agency Services Group—Tolling, Emergency Preemption, & Enforcement

- Facility and Segment Tolling—Automatic collection of tolls for facilities (bridges, tunnels, etc.) and limited-access highway segments, using vehicles' electronic identification as they pass by locations, determined wirelessly (GNSS plus pseudolites) or by beacon stations.

- Open Road Tolling—Automatic tolling applications that require details of vehicles travel along any specific roadway segments or distances over time.

- Preferential and Pay-to-Go Lane Use—Applications that involve authorization for and enforcement of fast lanes for HOV, preferred-fuel vehicles, and other priority vehicles, and for pay-to-go and market-based lane-use (or segment use) programs.

Would include interaction with drivers for authorizations, warnings, enforcement, charging, etc.

- Law Enforcement Assistance—Applications in which vehicle identification and position information is supplied to law-enforcement in real-time, to assist in arrests, investigations, and alerts.

- Electronic Traffic Ticketing—Applications where the vehicle identification, speed, and position is used for automated, non-real-time traffic ticketing, with real-time warnings and near-real-time delivery of e-tickets with proof of violation.

- Emergency Pre-emption—Applications which cause or require that network components be preempted in whole or in part by a government agency in a time of emergency, for highway flow and safety, individual aid and reporting, etc. *Essential in major emergencies with population fleeing in vehicles.*

Energy & Environment Services Group

- V2G Support—Dissemination and collection of needed information to support Vehicle to Grid (V2G) networks, both to vehicles when moving, and when parked and uploading electric power from or downloading to the Grid. Also, Fixed Wireless links to support V2G stations and infrastructure.

- Environmental Monitoring—Very wide area wireless links to monitoring stations in urban to very rural areas, for data and video collection day-to-day, and in natural or man-made environmental emergencies.

Infrastructure Support Group

- Network links—Wireless links between network infrastructure station components.

- ITS Data Backhaul—Applications which use the network for backhaul of ITS data, including but not limited to transmission of probe data from fixed sensors: for ITS public agencies including support of and interoperation with DSRC stations.

Commercial Applications Group

- Retail Transaction Applications—Applications that require the ability of a vehicle (owner) or occupant to conduct financial transactions with providers of goods or services.

- Vehicle Warranty, Insurance, and Lease Applications—Automatic reporting of vehicle use and systems status for preferential warranty, insurance, maintenance and lease, and roadside assistance contracts.

- Container Transport Tracking and Monitoring—Applications involving location, tracking, and security and status monitoring of major shipment containers.

- Premium Traveler Services (Onstar)—Services that require the vehicle to provide its position (and potentially additional data) to a commercial entity for the direct benefit of the vehicle occupants.

- Broadcast Entertainment—A broad application class encompassing all streaming quasi-real-time entertainment, news, and other media services on subscription or per-item basis.

- On-Demand Entertainment—A broad application class encompassing all entertainments services, such as video and audio services, that must be requested by the user in the vehicle, and which do not require real-time delivery.

- Commercial Wireless Systems Support—Provision of various location and other functions to commercial wireless network operators.

Emergency, Maritime, and Air Services Group

The 200 and 900 MHz high-power mobile equipment used for the ITS highway systems will be especially suitable for the following applications, and the eventual volume will make these cost effective.

- Emergency Services with Portable Repeaters—Applications using caches of equipment (portable repeaters and handheld version of the vehicle radios) that can be flown in for use in major emergencies to supplement the wireless systems of relief workers.

- Rural Air-to-Ground Services— In rural areas where the network would have extra capacity (using same architecture and spectrum) as in urban high-traffic areas, use of the capacity to provide high-speed mobile links to commercial and private aircraft, along well-used flight paths. (Supplement to the US 850 MHz air-ground wireless.)

- Maritime Services—Optimization of long-range coverage in costal and inland major waterways, for both location and high-speed communication links to maritime vessels, similar to those provided on land.

Data Dissemination Group—Network Website, and Handoffs to Other Wireless

- Network Website—Collection, processing, and dissemination of data involved in the above dissemination and collection applications. Most disseminated over the Internet with GUI display, including handoff to commercial mobile wireless networks, and additional data provided to public agency networks. Website data presentations may in large part follow Global System for Telematics (GST) (or alternative vehicular GUI display) for the same classes of data.

Integration Issues

A key factor to the appeal and ultimate success of a wide-area wireless network is how it complements and enhances existing or other planned services. In particular, the envisioned wide-area network should support or ideally become an integral piece of the puzzle in the federal Vehicle-Infrastructure Integration (VII) initiative based upon Dedicated Short-Range Communications or DSRC. (The FCC recognizes and classifies LMS and DSRC as the two US ITS radio services, but leaves integration up to the spectrum licensees and operators.)

With regards to VII specifically, it is essential to demonstrate that a wide-area network could not only complement but in fact accelerate the deployment of the federal vision for VII. The prevalent research approach for VII currently focuses on high-availability, low-latency, short-range communications through a protocol operating at 5.9 GHz and known as Dedicated Short-Range Communications (DSRC), that would be needed to provide safety-critical applications involving real-time data transmission when a possible crash is imminent, and for various other ITS services, from essential safety to commercial in nature. Short-range and wide-area network ("WAN") and protocols may complement each other in important ways:

(1) Certain applications are more suited to short-range, low-latency communications, at strategic locations (like intersections) while other may be better or only served by a wide-area network with continual communications, and in large part, mutli-QoS communications;

(2) Vehicle users will expect substantial and consistent coverage from any wireless capability built into vehicles, and even with hundreds of thousands of DSRC stations at major intersections and interchanges, the vast majority of roadways will not have coverage without complementary wide-area wireless systems (and expecting a wireless safety function to operate regularly when it often does not, may even be counterproductive or dangerous);

(3) Adopting a mix of strategically located short-range beacons within an encompassing regional wide-area wireless network, where the two forms of communication are substantially integrated, may be a practical and cost-effective approach to a global ITS wireless network;

(4) A WAN can be built and operated far more quickly and cost effectively than the desirable number of DRSC stations in a given major urban area, and thus, the WAN can provide regional network coverage in which the local DSRC stations can be increasingly added over time: the two each providing and coordinating many if not all important ITS services; and

(5) For these reasons, short-range and long-range communications may leverage off each other to offer a more compelling business case both in shorter term longer terms. The last two points are particularly crucial because the emergence of safety-critical applications made possible by DSRC requires a high-penetration rate for DSRC receivers--buy-in by automobile makers and the public--leading to a so-called "chicken and egg problem."

By coordinating the deployment of wide-area systems with that of DSRC stations, it should be possible to support dual-system, multi-band end-user vehicle transceivers that provide drivers with immediate benefits of many core ITS applications via wide-area systems, and use them to support increasing numbers of DSRC stations and the additional ITS safety functions they will provide at their strategic locations.

FURTHER READING

The Telesaurus website, telesaurus.com, contains descriptions, depictions, and URL links related to the above.